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Turkish Students' Understandings about Some Basic Astronomy Concepts: A Cross-Grade Study

Mehmet Altan Kurnaz

Kastamonu University, Turkey

Abstract: In the present study, students' ideas concerning some basic astronomy concepts are investigated. One hundred and sixty-two Turkish students at different grades (from primary and secondary school levels) participated in this study. Data of the study were gathered using a test, which required participants to present their answers by both writing and drawing. The results revealed that participants at all grades were not sufficient at written and visual responses, including many alternative ideas. It is thought that the results of this study will extend the related literature and make contribution to the development of astronomy education.

Key words: Basic astronomy concepts % Research into learning % Course curriculum

INTRODUCTION

Astronomy, one of the most popular science fields, has an important role and interdisciplinary perspective in science education because it has a relation with natural phenomena about earth, space and nature. Another important astronomy feature is that it enhances an important role in the development of science. Therefore, astronomy should be seen as an important component of education. In this manner by considering high student' interest, astronomy education, in relation to basic astronomy concepts, has been included in elementary and high school curriculums in developed and developing countries since the beginning of 1970 [1-3]. This issue has been highlighted in such reports from the Australia [4], United States [5,6], Israel [7] and the United Kingdom [8]. Recently, the Turkish education system has organized or reorganized their curriculums in all educational fields under the European Union Standards, including astronomy education. The Turkish researchers that are aware of this have begun to assess the effects of the new curriculums on students' understanding whether it is scientific.

This study highlights one aspect of the Turkish students' understanding, with a view to comparing different grades, of concepts of astronomy. Specifically, the study was aimed to investigate understanding of basic astronomy concepts of Turkish students at different grades with a view to examining how their perception might be effected from the new Turkish curriculum. The study makes the assumption that understanding of students is constructed, at least in part, in terms of their science curricular experiences. Hereby, since there is not enough science education study which investigates understanding of Turkish students about basic astronomy concepts, the study fills in this gap. It can be claimed that conclusions of the study are significant, not only to Turkish science educators but also to science educators elsewhere, who have, or plan to use a similar curriculum. It is also believed that the findings of this study make emotional effects to highlight science education researchers, teachers, curriculum developers and policy makers.

General Characteristics of Astronomy in Turkish Curriculum: Here, the Turkish astronomy curriculum will be summarized briefly. Turkish school system has two frames as elementary (1st to 8th grades) and secondary (9th to 12th grades) and has a centralized curriculum which was followed by all over the schools throughout the country with the same educational materials. Astronomy is a major component of the science curriculum in Turkey and the main objectives of the curriculum includes representing changes over time and the objects and motions of the sky, day and night, seasons, the relationship between the earth, moon and sun; and our planet's shape and size; and solar system, stars, galaxies, quasi-stellar and the expansion and age of the Universe [9,10]. Distribution of the fundamental characteristics of the recent curriculum related with astronomy to grades can be seen as in Table 1.

Corresponding Author: Mehmet Altan Kurnaz, Kastamonu University, Turkey.

As can be seen from Table 1, Turkish students begin to gain information about fundamental astronomy concepts, starting from grade K-3. Even though the Turkish primary and secondary school curriculums have been reconstructed, all grades will be using the new curriculum by 2011-2012 academic year, because of the fact that it is currently being implemented in a step by step way.

Theoretical Framework: Meaningful learning and the factors effecting to it have been examined from various perspectives over the years and it is mostly accepted that learning outcomes are affected by many factors. Since students' alternative conceptions have been seen to influence the quality of learning in a significant manner, it has been generally accepted starting point to perform meaningful learning. Specifically, in this area, since effective learning of basic astronomy concepts is essential for understanding and explaining natural phenomena, students' alternative conceptions with these concepts have been the subject of on-going research all over the world more than two decades [11-17]. These studies revealed that students had various non-scientific perceptions from different standpoints. Thus, this study is framed within related literature that claimed that students have various alternative ideas about basic astronomy concepts.

Students come to formal science instruction with non-traditional ideas that deal with the natural objects and events that are highly tenacious and resistant to change and strongly influence new learning [18,19]. These misapplied interpretations are collectively known as alternative conceptions which may called 'misconception', 'pre-conception', 'pre-existing knowledge', 'children's science' etc [19-21]. Alternative conceptions have their origins from a set of personal experiences including direct observation and perception, insufficient connection between prior knowledge and new one and language, as well as in teachers' teaching method and textbook. [19,22]. It is known that students construct their perceptions in accordance with their pre-existing knowledge [20,23]. If pre-existing knowledge of students includes alternative conceptions or does not correspond to scientific definitions, students may fail to learn deeply [24-26]. Thus, science educators should have a deep understanding on students' probable alternative conceptions [27] and this makes the study of student understanding so critical to overcome learning obstacles.

In this study, it was aimed to (i) investigate understanding of basic astronomy concepts of Turkish students at different grades and the differences in understanding between these grades (ii) to determine the effects of learning environments designed in terms of the new Turkish curriculums. To this end, sun, earth, moon, star, planet and natural satellite concepts are determined as the research concepts, because of the fact that (i) students encounter news about these concepts during daily life, (ii) they are the central concepts of Turkish astronomy curriculum, (iii) according to researcher, there is a need to elicit how students define sun-star, earth-planet and moon- natural satellite duo concepts as comparatively.

Research Method: Under this title, participants of the study, research design and data collection tool and analysis method will be explained.

Research Design and Participants: The study was conducted as a survey design using an instrument to elicit ideas of Turkish students about basic astronomy concepts.

The study was completed in 2011. Participants in this study comprise of one hundred sixty two 7-11 grades students (30 of them from 7th grade, 36 of them from 8th grade, 34 of them from 9th grade, 32 of them from 10th grade and 30 of them from 11th grade) who come from primary and secondary schools of a city in Turkey. Why grades 7-11 students selected as the study group? The reason of this is that Turkish students gain more detailed information about the research concepts starting from grade 7, Table 1. Also, all of the participants had taken courses related the research concepts in terms of the same curricula.

Data Collection Tool and Analysis: In this study, data were gathered through the use of a test, including of two sections. The first section, related to the conceptual explanation of the concepts, consists of the questions: What comes to your mind when you hear the concept of the (respectively) sun, earth, moon, star, planet and natural satellite? Explain it. In the second section of the test, it was asked students to draw pictures of the sun, earth and moon and pictures of a star, planet and natural satellite. In the second section, it was also asked students to draw the sun-earth-moon system, consisting of showing their movements.

Content analysis method was employed to analyze the collected data in consideration of the characteristics of them [28]. In this manner, the codes were organized for students' conceptual explanations and categories were formed for students' drawings.

RESULTS AND DISCUSSIONS

Analyzes of student answers were presented under the headings of; description situations of astronomical bodies, images for astronomical bodies and images for the sun-earth-moon system.

Description Situations of Astronomical Bodies: The obtained codes from the participants' answers given for the conceptual questions are presented in Table 1.

As indicated in Table 2, there were clear differences about students' conceptual understandings for all research concepts and it could be claimed that students' conceptual understandings were parallel in all grades. Only, the moon was widely accepted as 'satellite of the earth' by almost all of the participants in all grades and the earth was defined as 'a habitable planet' by almost all of the participants in grades 9 and 11. Also, more than fifty percent of the participants have common understandings for the sun, earth and satellite and these are 'sun is source of heat and light', 'earth is a habitable planet' and 'natural satellite is a celestial body in orbit around the planet'. On the other hand, the bad rating was that understanding of the participants for the star and planet concept was not well. There were few sound responses as seen in the table. Besides, a manner consistent with earlier studies [11-13,16,17,30-32] some participants have alternative ideas as given in table, such as moon is the source of heat and light, star is a substance separated from the sun, planet is a meteorite and satellite is a small planet. Some sample participant answers are given below.

- The sun, emitting heat and light, is the largest celestial body in the solar system (Responses of an 8th grade student).
- The earth, a planet which has suitable living conditions (Responses of a 9th grade student).
- The moon, the earth's satellite. Reflects the light from the sun (Responses of a 10th grade student).
- A star is a celestial body emitting heat and light. Since they are far away from the earth, we see them very small (Responses of an 8th grade student).
- A star is a planet which produces light (Responses of a 9th grade student).
- Moving objects in orbit are called planet (Responses of a 7th grade student).
- A natural satellite is a celestial body orbiting around planet (Responses of an 11th grade student).

A close attention to participants' conceptual responses for the sun and star in Table 2 reveals that most of the participant made different explanations. One of the focuses of this study is to highlight how participants define sun-star duo concepts as comparatively. In this manner, consistent with the earlier findings [29,31,33, most of the participants did not mention the sun to be the same type of object as a star and they generally used their characteristics to define them. The sun is visible in day time and appears bigger than stars. These observable differences between the sun and stars may be the possible reason of understanding

Table 1: Distribution of the fundamental characteristics of the recent curriculum to grades

Grades	Learning Area	Unit	Objectives
3	Yesterday, today, tomorrow	No name	Describing changes over time and the objects and motions of the sky, day and night, seasons.
4	Earth and the Universe	Our planet, earth	Describing shape and structure of the earth, basically.
5		Earth, sun, moon.	Describing shape and size of earth, sun and moon, movement of earth and moon and movement relationship between earth, sun and moon.
6		What does the earth crust included?	Describing earth's crust.
7		The Solar System and Beyond: The Puzzle of Outer Space	Describing the solar system bodies, space research and technology and representing stars and galaxies basically.
8		Natural processes	Describing formation process of earth and climate and weather events.
11	Stars and Quasars		Describing the life cycle of stars, classification of stars, galaxies, quasi-stellar and the expansion and age of the universe.

Table 2: Participants' conceptual answers to research concepts

		7		8		9		10		11	
Object	Codes for Student Answers	f	%	f	%	f	%	f	%	f	%
Sun	Source of heat and light	15	50,0	21	58,3	22	64,7	20	62,5	22	73,3
	A star	10	33,3	12	33,3	13	38,2	5	15,6	3	10,0
	Source of light	7	23,3	6	16,7	5	14,7	6	18,8	4	13,3
	Source of heat	4	13,3	1	2,8	-	-	-	-	2	6,7
	A planet	2	6,7	-	-	-	-	1	3,1	-	-
	Source of energy	-	-	-	-	3	8,8	2	6,3	-	-
	Cause of formation of the seasons	-	-	-	-	1	2,9	-	-	-	-
Earth	A habitable planet	20	66,6	22	61,1	30	88,2	25	78,1	26	86,7
	The planet covered by water	12	40,0	8	22,2	2	5,9	4	12,5	-	-
	A planet orbiting the sun	5	16,7	7	19,4	3	8,8	2	6,3	2	6,7
	A planet which has atmosphere	-	-	6	16,7	7	20,6	4	12,5	-	-
	A planet	-	-	1	2,8	2	5,9	2	6,3	-	-
	A planet breaking off the sun	-	-	-	-	1	2,9	-	-	2	6,7
	Living area	-	-	-	-	1	2,9	-	-	-	-
	A planet which is satellite of the sun	-	-	-	-	-	-	-	-	1	3,3
Moon	Satellite of the earth	30	100	33	91,7	30	88,2	29	90,6	30	100,0
	An object reflecting light	9	30,0	8	22,2	4	11,8	6	18,8	8	26,7
	Orbiting around the earth	4	13,3	3	8,3	-	-	-	-	-	-
	Source of light	4	13,3	2	5,6	1	2,9	1	3,1	3	10,0
	Orbiting the sun	2	6,7	-	-	-	-	-	-	-	-
	Source of heat and light	3	10,0	2	5,6	1	2,9	-	-	-	-
	A star	-	-	-	-	1	2,9	-	-	-	-
	A small planet	-	-	1	2,8	-	-	-	-	1	3,3
Star	An astronomical body	10	33,3	8	22,2	12	35,3	13	40,6	4	13,3
	Source of light	9	30,0	11	30,6	8	23,5	7	21,9	13	43,3
	Source of heat and light	6	20,0	4	11,1	5	14,7	5	15,6	4	13,3
	Artificial light source	2	6,7	-	-	1	2,9	-	-	-	-
	Meteorite	1	3,3	-	-	1	2,9	-	-	-	-
	Substance separated from the sun	1	3,3	2	5,6	-	-	-	-	3	10,0
	A gas cloud	-	-	-	-	2	5,9	2	6,3	-	-
	Light-producing planet	-	-	-	-	1	2,9	-	-	-	-
	Non-orbital celestial bodies	-	-	-	-	-	-	-	-	1	3,3
	Sun-like objects	-	-	-	-	-	-	-	-	1	3,3
	No response	3	10,0	11	30,6	5	14,7	11	34,4	5	16,7
Planet	Celestial body	10	33,3	6	16,7	11	32,4	8	25,0	2	6,7
	Moving object in orbit	8	26,7	10	27,8	14	41,2	6	18,8	9	30,0
	Living area	5	16,7	3	8,3	-	-	4	12,5	1	3,3
	Objects that have satellite	3	10,0	2	5,6	-	-	-	-	1	3,3
	Meteorite	-	-	2	5,6	1	2,9	4	12,5	-	-
	Masses are connected to a system	-	-	-	-	1	2,9	-	-	-	-
	Spherical shape that does not have energy	-	-	1	2,8	-	-	-	-	2	6,7
	No response	9	30,0	12	33,3	7	20,6	14	43,8	11	36,7
Natural Satellite	A celestial body in orbit around a planet	18	60,0	22	61,1	23	67,6	20	62,5	16	53,3
	Small planet	2	6,7	-	-	1	2,9	1	3,1	3	10,0
	Broadcasting tool	4	13,3	7	19,4	4	11,8	3	9,4	1	3,3
	Top view of the world	-	-	-	-	-	-	-	-	1	3,3
	No response	6	20,0	7	19,4	6	17,6	8	25,0	8	26,7

Table 3: Participants' images for the research concepts

		7		8		9		10		11	
Object	Characteristics of Images	f	%	f	%	f	%	f	%	f	%
Sun	A roughly round drawing	30	100,0	36	100,0	34	100,0	32	100,0	30	100,0
Earth	A roughly round drawing	30	100,0	36	100,0	34	100,0	32	100,0	30	100,0
Moon	A roughly round drawing	20	66,7	23	63,9	29	85,3	30	93,8	24	80,0
	Crescent moon	10	33,3	13	36,1	5	14,7	2	6,2	3	10,0
	No response	-	-	-	-	-	-	-	-	3	10,0
Star	A roughly round drawing	9	30,0	5	13,9	12	35,3	8	25,0	8	26,7
	Five-point star	21	70,0	31	86,1	21	61,7	22	68,8	16	53,3
	No response	-	-	-	-	1	2,9	2	6,2	6	20
Planet	A roughly round drawing	19	63,3	26	72,2	23	67,6	22	68,8	20	66,7
	A roughly round drawing with ring	11	36,7	5	13,9	11	32,4	10	31,3	5	16,7
	No response	-	-	5	13,9	-	-	-	-	5	16,7
Natural	A roughly round drawing	22	73,3	20	55,6	18	52,9	18	56,3	20	66,7
Satellite	Drawing as crescent moon	2	6,7	-	-	-	-	-	-	3	10,0
	A roughly round drawing with ring	-	-	1	2,8	-	-	-	-	-	-
	Drawing as artificial satellite	6	20,0	12	33,3	12	35,3	10	31,3	4	13,3
	No response	-	-	3	8,3	4	11,8	1	12,5	3	10,0

differences seen in the participants. Likewise, there is not common perception among the participants for earth-planet duo concepts and some of the participants had nonscientific ideas for planet concepts. There is a life in the earth among the other planets known by participants, probably owing to this; most of the participants tend to define the earth as a habitable planet where as they define a planet as celestial body. Most of the participants gave responses for moon-natural satellite duo concepts more closely resembling scientific thought. However, some of the students have alternative ideas, as moon is a small planet. These results were consistent with the earlier studies [16,34]. In a result different from the earlier results, some of the participants defined a natural satellite by using a characteristic of an artificial satellite. They define a natural satellite as a broadcasting tool. In fact, this may caused from not knowing the classification of satellite as natural and artificial despite the fact it is given in the curriculum. Here, it can be claimed that participants were more successful about the sun, earth and moon concepts than star, planet and natural satellite concepts. These results prove that there has not been a sound effect of the learning environments designed in terms of the new curriculum about students' conceptual understandings. It is believed that these results can be explained in the context of the learning situations implemented in terms of the new curriculum. Even though there is systematic perspective to introduce the research concepts in Turkish curriculum (Table 1), there are some problems to teach astronomy units by Turkish teachers, because the fact that few teachers have had astronomy and behind this failure lies in the scarcity of the astronomy department in Turkey [9]. These results were confirmed with the earlier studies conducted in Turkey [10,11,13,17,31,33,35]. In earlier findings, students in different grades (from primary school to university) were not at the intended level in explaining the research concepts of this study scientifically and had various alternative ideas. Here, the agreement between the results of the earlier studies actually implies that learning difficulties regarded with the astronomy are valid for all age groups. These findings proved that students' lack understandings or alternative ideas reported decades ago in the literature still endured and in Turkey, this may probably caused from teachers lack self-confidence in implementing the astronomy topics of the new curriculum.

Images for Astronomical Bodies: All participants' images for the research concepts were classified in terms of their characteristics. Table 3 shows the frequencies and percentages of images of the research concepts drawn by the participants.

As indicated in Table 3, contrary the conceptual understandings of the research concepts, there was a general harmony in participants' images for the research concepts and this harmony was also valid for all grades. Especially, images of all participants were the same for the sun and earth. In the light of the new curriculum, textbooks present spherical model of the sun, earth and moon. Thus, images of the sun and earth drawn by all participants of this study and images of the moon drawn by more than half of the participants, in all grades, were acceptable in terms of the new curriculum (Figure 1).

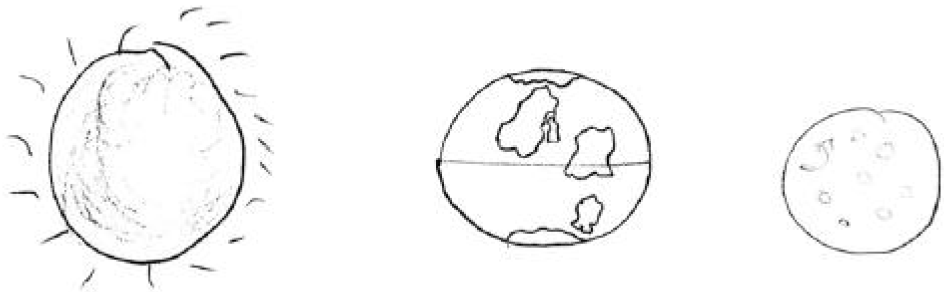

Fig. 1: Sample drawings showing the sun, earth and moon (respectively) by an eighth grade student

Fig. 2: Sample drawings showing the responses of two students from grades 7 and 11 for the moon

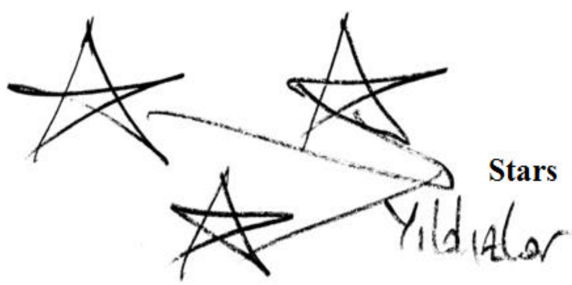

Fig. 3: Sample drawing showing stars by a ninth grade student.

There is a clear success to represent shapes of the sun, earth and moon. This finding is similar to what Starakis and Halkia [36] reported. In their study, the researchers indicated that the sun, earth and moon depicted by the students as a roughly round drawings. Since these objects are visible in day or night time in daily life, we can voice an overall success supported with daily life observations. However, explaining the success backed by their daily life cannot be valid for all the participants because some of the participants, in all grades, had nonscientific ideas for shapes of the moon caused from daily life (Figure 2).

Here, contrary to earlier findings, it is not interesting to depict crescent moon as the shape of the moon by some of the participants in all grades. The Turkish flag is a red flag with a white crescent moon and a star and it is generally called as 'moon star' in books, magazines, television programs and daily colloquial. Thus, students' nonscientific ideas may explain with cultural effects, despite the fact that there is an important emphasis on this issue in the curriculum. These findings showed that there was a lack training to construct participants' perceptions about shape of the moon.

As indicated in Table 3, the participants' responses showed that almost all of the participants, in all grades, were depicted appropriate images to the curriculum for the planet. In all grades, more than half of the participants were drawn natural satellites' picture as given in the curriculum. The other drawings by the other participants for a natural satellite were nonscientific and these included 'drawing as crescent moon', 'a roughly round drawing with ring' and 'drawing as artificial satellite'. Also, about quarter of the participants in all grades depicted a star as appropriate to the curriculum. However, more than half of the participants in all grades represented nonscientific shapes to a star. They did it as five-point star (Figure 3).

It is not interesting to depict five-point star as the shape of a star by most of the participants in all grades, too. In the Turkish curriculum, drawing five-point star as the shape of a star defines as misconceptions and it highlights that this an important case which teachers must endeavor to overcome. As mentioned above, it is thought that since there is a deep effect of Turkish flag called as 'moon star', students tend to depict the star as in the Turkish flag. This finding is consistent with what 1yibil and Sa–lam Arslan [31] reported. In these earlier studies, the researchers highlighted that few students depicted a scientific drawing whereas most of the students drew non-scientific shapes for the stars. These findings prove that there has not been much progress to develop students' perceptions in terms of the curriculum and there has not been a noticeable difference between grades.

Table 4: Participants' overlapped images about the sun-star, earth-planet and moon-natural satellite duo concepts

		Sun		Earth		Moon					
		A roughly round drawing		A roughly round drawing		A roughly round drawing		Crescent moon		No response	
Object and Characteristics of its Images		f	%	f	%	f	%	f	%	f	%
Star	A roughly round drawing	42	25,9	-	-	-	-	-	-	-	-
	Five-point star	110	67,9	-	-	-	-	-	-	-	-
	No response	10	6,2	-	-	-	-	-	-	-	-
Planet	A roughly round drawing	-	-	110	67,9	-	-	-	-	-	-
	A roughly round drawing with ring	-	-	42	25,9	-	-	-	-	-	-
	No response	-	-	10	6,2	-	-	-	-	-	-
Natural Satellite	A roughly round drawing	-	-	-	-	78	48,1	16	9,9	1	0,6
	Drawing as crescent moon	-	-	-	-	2	1,2	3	1,8	-	-
	A roughly round drawing with ring	-	-	-	-	-	-	1	0,6	-	-
	Drawing as artificial satellite	-	-	-	-	37	22,8	12	7,4	1	0,6
	No response	-	-	-	-	9	5,6	1	0,6	1	0,6

Table 5: Characteristics of the participant responses to the sun-earth-moon system

					7		8		9		10		11	
	Sun	Earth	Moon	Types of motion	f	%	f	%	f	%	f	%	f	%
Size	Big	Middle	Small	-	30	100	31	91,2	34	100	30	93,8	30	100
Motion	Does not rotate around itself	Rotating around itself and the sun	Rotating around itself and the earth	Type I	-	-	-	-	1	2,9	1	3,1	2	6,7
			Rotating around the earth	Type II	2	6,7	1	2,8	2	5,9	3	9,4	4	13,3
		Rotating around the sun	Rotating around the earth	Type III	22	73,3	23	63,9	28	82,4	25	78,1	14	46,7
	Rotating around itself	Rotating around itself and the sun	Rotating around the earth	Type IV	-	-	-	-	-	-	-	-	2	6,7
	Not mentioned			-	6	20,0	7	19,4	3	8,8	1	3,1	8	26,7
No response				-	-	-	5	13,9	-	-	2	6,3	-	-

In the recent study, participants' responses about the sun-star, earth-planet and moon-natural satellite duo concepts were also analyzed comparatively. Table 4 shows the frequencies and percentages of overlapped images for the duo concepts drawn by the participants.

Considering the cognitive development, students are expected to acquire a broader sense of conception. However, findings given in Table 4 prove the existence of lack of perception. In other words, some participants evaluated in the context of this study were found to have difficulty in depicting common images with regard to the duo concepts. Specifically, there is a lack of perception related with the sun-star and moon-satellite duo concepts. Participants depicted common and scientific images to the sun but could not construct a scientific framework about shape of a star. As indicated in table, more than half of the participants were preferred to depict a star like a five-point star rather than a round drawing like the sun (Figure 4). It is believed that cultural values and experiences regarding with Turkish flag and observable differences between the sun and stars have impacted the cognitive learning of participants on this issue. Thus, students should be allowed to construct a cognitive framework by integrating shapes of a star and the sun. This signifies that more attention needs to instruct shape of a star. Also, future studies might aim to elicit why students draw different images to the shapes of a star and the sun.

Likewise, Table 4 also reveals that images of some of the participants for the natural satellite-moon duo concepts are not appropriate to the each other. Some of the participants who depicted a roughly round drawing for the moon put forth that shape of a natural satellite is like a crescent moon or artificial satellite. Also, some of the participants who represented nonscientific images as crescent moon put forth that shape of a natural satellite is like round or artificial satellite (Figure 5). Hereby, future studies might aim to determine why students draw different images to the shapes of a natural satellite and the moon, too.

Images for Sun-earth-moon System: All participants' images for the sun-earth-moon systems were classified in terms of showing size and motion of the system bodies correctly. Table 5 shows the frequencies and percentages of participant responses.

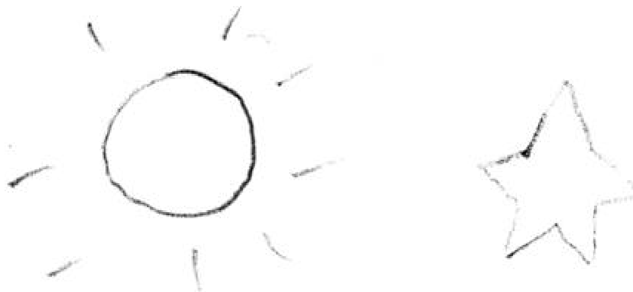

Fig. 4: Sample drawing showing the sun and a star by a tenth grade student

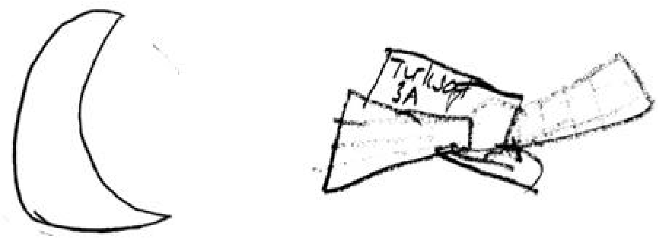

Fig. 5: Sample drawing showing the moon and a natural satellite by a seventh grade student

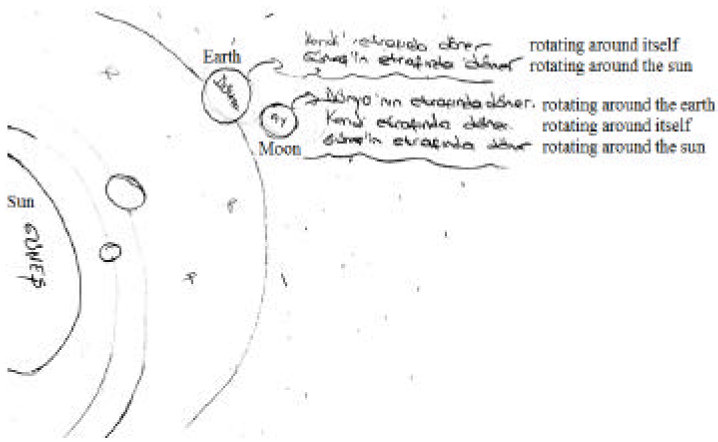

Fig. 6: Sample drawing showing the motion of the body of sun-earth-moon system by a ninth grade student

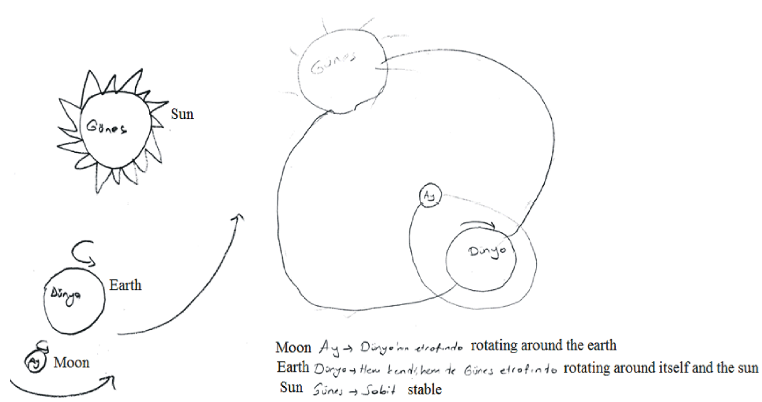

Fig. 7: Sample drawing showing the motion of the body of sun-earth-moon system by a seventh and tenth grades student

As indicated in Table 5, almost all of the participants in all grades were depicted size of the system bodies correctly. However, it cannot be mentioned that there is a common sound perception among participants in all grades for motion of the system bodies. As given in table, participants' responses for motion of the system bodies were classified in four types. Type I is seen in grades 9-11, type II and type III are seen in all grades and type IV is seen only in grade 11. All types indicate that participants have lack of perception or alternative ideas for the motion of system bodies. Also, although some of the participants were depicted the system bodies, they did not show off motion of the bodies. Thus, they were not classified.

A close attention to type I, type II and type III in the table reveals that most of the participants depict motionless sun. It is clear that participants classified within type I and type II considered the earth as rotating around itself and the sun, whereas participants classified within type III put forth the earth as rotating only around the sun. Besides, participants classified within type I indicated the moon as rotating around itself and the earth and participants classified within type II and type III represented the moon as rotating around the earth. For the participants classified within type IV depicted the sun as rotating around itself, the earth as rotating around itself and the sun and the moon as rotating around the earth (Figure 6 and 7). In fact almost all of the participants, depicted an image, showed off the sun motionless. This finding is consistent with previous studies findings [16,37]. In earlier studies, researchers indicated typical examples of student drawings regarding with phases of the moon, the sun-earth-moon system or etc. where students depicted the sun motionless. Backed by the findings of this study, it can clearly not mention that participants have a meaningful success for the motion of system bodies and there is a significant difference in grades.

These results can be explained in the context of lack of training and the lack of orientation of the curriculum. In terms of the 7th grade science and technology course curriculum, students should be able to model the solar system [38]. To this end, the curriculum suggests a sample activity for the instruction of the solar system and there, it highlights constructing a solar system model, representing especially movements of the planets. Probably owing to this sample activity, a Turkish textbook present this subject like this:

"let make a solar system model like in the picture which shows the sun as stable with color play dough, cardboard and copper wire. Show the orbits of planets around the sun by using cooper wires which can move" [39]. Here, there is a lack of emphasis about the sun rotating on its axis. Thus, it is thought that one of the reasons of participants' thinking that the sun is motionless may caused from learning environments where the textbook written in terms of the curriculum was used. This finding is consistent with previous studies. Cin [11] reported textbooks, teachers and teaching materials were attractive reasons of constructing alternative ideas of students.

Implications: The results of this study were indicated that although all participants had taken related courses which designed in terms of the new curriculum, most of the participants had alternative ideas or lack of perception about the research concepts and these were generally similar in all grades. Since astronomy is of vital importance and has attracted attention of man from time immemorial and continues to do so, much of the researches in the study of student understanding have been conducted about basic astronomy concepts. Recently, we have been aware of alternative ideas of students on this issue. It is clear that alternative ideas of students are important obstacles in effective learning and we have to overcome it as science educators. In this manner, the new Turkish curriculums are claimed that it has a recent and more modern perspective and opportunities to remove alternative ideas. However, the findings of this study do not validate this claim. Thus, this study sets forth implications for teachers, researchers, curriculum developers and policy makers to see barriers and opportunities.

This study was conducted with restricted participants, including 162 students from different grades. Although students in Turkey have been educated through the same curricula by using the same textbook and by the teachers who had generally similar backgrounds, the assertions may not interpret in a wide perspective. There are, of course, limitations to this study. Thus, on the one hand, more work is needed to elicit student understandings to assess the effects of the new curriculum. On the other hand, more work is needed to overcome the underlying causes of difficulties students have in the research concepts and to carry out necessities of the new curriculum effectively. To this end, first of all, every effort must be made to help teachers have to gain confidence in teaching their topics. In this manner, more research into constructing more effective teaching strategies on teaching astronomy topics should be developed and these strategies should also be presented to teachers with in-service training.

Students come to the classrooms with knowledge and attitudes constructed with daily experiences and these prior knowledge and attitudes are strong frameworks for students to interact with environments. Since students have an observational base of daily events in the sky, students may have some ideas well different from scientific ones. For an effective teaching, teachers need to take account of these prior ideas. It is clear that knowing students' ideas is important ever since prior knowledge has been seen as the starting point to perform meaningful learning in astronomy, as in case of the other disciplines. In this context, the results of this study provide useful information to teachers to consruct their learning and teaching environment. If a teacher has a clearer understanding of student alternative ideas about the research concepts, (s)he can organize their teaching in terms of it, perhaps by discussing alternative ideas with students, using models taken into account the underlying points indicated in this study, using teaching materials to overcome the learning obstacles such as concept map, conceptual change texts, data meaning-analysis table and using in assessment processes.

Moreover, the results of this study may also provide useful information to students to become aware of their views and uncertainties. There is a need to encourage students to modify their own learning activities where they may create or produce new knowledge in science. Thus, the results of this study have implications for students. Once students know what alternative ideas possess by peers, students can challenge to their alternative ideas and modify their learning processes. On the other hand, it is recently expected from students to develop reflective skills to become self regulated and lifelong learners. Thereby, the results of this study may provide an opportunity for a deep learning to the students who have reflective skills.

In addition, since curriculum implementation studies used to investigate students' achievements [40], the implications of this study are also clearer for textbook writers and curriculum developers. This is a chance to offer textbook writers and curriculum developers to reorganize the textbook/curriculum. For example, a textbook writer should highlight the sun as a star which rotating on its axis.

There is a need for understanding the duo concepts in a broader sense, e.g. students should be able to demonstrate same shapes for the sun and a star. In curriculums, students are expected to have activities, including prediction, observation and explanation to learn fundamental characteristics of celestial bodies. Predicting and observing characteristics of the sun, moon and stars and then discussing and explaining the differences between the sun and stars, the moon and natural/artificial satellite and the earth and planets in learning environments may use to broaden students' ideas. In this way, students may integrate their information gained from learning environments wherein physical (concrete) models use to visualize solar system bodies with their prior knowledge and observations.

Since the sun-earth-moon system is our native system and is the system with which we are most intimately associated, information about the system need to be developed to understand some natural phenomena such as day and night formation, season formation, phases of the moon, positions of the system bodies. Thus, instructional activities should not be restricted merely to conceptual definitions. Teaching activities should be also included inquires, observations, discussions and modeling about characteristics of the system and effects of it to livelihood, health and transportation.

The researchers studied on astronomy education may carry out this study once more by gathering data through one-on-one interviews with students. Here, they may especially focus on student drawings, including why students think that shapes of the sun and a star, shapes of the moon and a natural satellite are different.

In summary, this study focuses on student understandings on the sun, earth, moon, star, planet and natural satellite concepts and the results indicate that Turkish students from different grades have difficulties to understand and visualize these concepts. Therefore, there is still need for improvement in this issue.

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